

REMARKS

Summary of Office Action

Claims 1-60 were pending in the above-identified patent application. Of those, claims 31-60 have been withdrawn as being drawn to a non-elected invention.

The Examiner rejected claims 1-3, 7, 8, 10, 11, 14, 15, 17, 18, 21, 22, 24, 25, 28 and 29 under 35 U.S.C. § 102(b) as being anticipated by Nakabayashi et al. U.S. Patent 6,114,095. Claims 1-30 were rejected under 35 U.S.C. § 102(e) as being anticipated by Stanton et al. U.S. Patent 6,258,489. Claims 4-6, 9, 12, 13, 16, 19, 20, 23, 26, 27 and 30 were rejected under 35 U.S.C. § 103(a) as being obvious from Nakabayashi in view of Stanton.

Summary of Applicants' Reply

Applicants have canceled claims 1-30, and have added new claims 61-70, in order to more particularly define the invention. The Examiner's rejection is respectfully traversed.

Applicants have also amended Paragraph [0036] of the specification to correct a typographical error.

Applicants' Reply to the Prior Art Rejections

Claims 1-3, 7, 8, 10, 11, 14, 15, 17, 18, 21, 22, 24, 25, 28 and 29 were rejected under 35 U.S.C. § 102(b) as being anticipated by Nakabayashi. Claims 1-30 were rejected under 35 U.S.C. § 102(e) as being anticipated by Stanton. Claims 4-6, 9, 12, 13, 16, 19, 20, 23, 26, 27 and 30 were rejected under 35 U.S.C. § 103(a) as being obvious from Nakabayashi in view of Stanton. These rejections are respectfully traversed.

Applicants' invention is a semiconductor pattern mask for printing a pattern that, without the benefit of applicants' invention, would be distorted by three-leaf aberration because the pattern of features

on the mask is a dense but nonuniform repeating pattern that exhibits three-fold symmetry. As explained in Paragraphs [0021] and [0022] of applicants' specification, masks with patterns that are not dense-- i.e., whose features are relatively far apart -- do not suffer from three-leaf aberration even if the pattern exhibits three-fold symmetry. Similarly, masks with a uniform distribution of features do not suffer from three-leaf aberration even if they are dense -- i.e., if their features are close together. Rather, masks that will suffer from three-leaf aberration are those whose patterns are dense -- i.e., whose features are close together -- but nonuniform -- i.e., having spaces between features with the size of the spaces on the order of the size of the features (see specification, page 6, lines 14-15 and 20-21). Three-leaf aberration is a real problem of real imaging systems, which is not addressed in connection with theoretical ideal systems.

According to the invention, the dense nonuniform repeating pattern on the mask, which exhibits three-fold symmetry, is changed so that it no longer exhibits three-fold symmetry. One way that this can be accomplished is to remove the nonuniformity of the pattern by inserting nonprinting features¹ (e.g., sub-resolution features) in the empty spaces -- because it has been observed that the presence of such features "counts" in whether or not the pattern exhibits three-fold symmetry, even if the features are too small to print, but the change is one that does not change the features printed by the mask on the substrate. Another way to break three-fold symmetry is to remove the repeating nature of the pattern by changing the transmissivity of only some of the printing features, while leaving other printing features unchanged. New claim 61 (and its new dependent claims) is directed specifically to a mask in which three-fold symmetry is broken by having different kinds of features,

regardless of what the difference is. For example, dependent claims 65-67 and 70 are directed to a mask where the three-fold symmetry is broken by adding non-printing features, while dependent claims 68-70 are directed to a mask where the three-fold symmetry is broken by having features of different transmissivities. (Note that claim 70 combines different transmissivities with non-printing features.)

One feature of the invention, as defined in claim 62, is that the added features (the features in a group of second features) do not surround the original features (the features in a group of first features). It is clear from FIGS. 5, 8 and 9 that the relationship of the placement of the second features to the placement of the first features is irregular, in that no first feature is surrounded by second features, and the respective ones of the first features have different spatial relationships with their respective nearest second features.

Neither Nakabayashi nor Stanton shows or suggests applicants' invention. There is no discussion in either reference of three-fold symmetry or three-leaf aberration, and accordingly no teaching or suggestion of the placement of features to break up three-fold symmetry. Moreover, the mask patterns shown in the references are completely regular and therefore do not exhibit three-fold symmetry, so there is no inherent disclosure of breaking up three-fold symmetry.


In addition, in both Nakabayashi and Stanton, each original feature of the mask is surrounded by four of the added features. There is no disclosure or suggestion in either of the references of placing the added features in an arrangement other than one that surrounds the original features.

For these reasons, applicants respectfully submit that claims 61-70 are patentable.

Conclusion

For the reasons set forth above, applicants respectfully submit that this application, as amended, is in condition for allowance. Reconsideration and prompt allowance of this application are respectfully requested.

Respectfully submitted,



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